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DEPARTMENTS.

SOLUTIONS OF PROBLEMS.

ARITHMETIC.

120. Proposed by ELMER SCHUYLER, B. Sc., Professor of German and Mathematics in Boys' High School, Reading, Pa.

How many balls 1 inch in diameter can be put in a cubical box 1 foot in the *clear* each way, putting in the maximum number? [From Greenleaf's *Treatise on Algebra.*]

II. Solution by J. M. ARNOLD, Crompton, R. I.

In regard to the solution of Problem 120, given in the January number, it seems to me that the total number of balls, 2147, is not the maximum number that can be placed in the box.

Suppose we pack it this way: Place 144 balls on the bottom, then a layer of 121, and so on alternately until fifteen layers have been put in.

Now fill with sawdust so that the sawdust is just level with the tops of the balls. We have left a clear space of 12×12 and a little more than 1 inch in depth. Into this space can be placed 150 balls, by first placing a row of 12 balls against one side of the box, then a row of 11, and so on alternately until thirteen rows are put in; making 7 rows of 12 and 6 of 11 balls each, 150 in all.

The distance between the center lines of the rows will be $\frac{1}{2}\sqrt{3}$.

And $12\times\frac{1}{2}\sqrt{3}+1=11.3923$. $12-11.3923=.6077$ inch to spare.

For the whole box we have:

Eight layers of 144 each=1152
Seven layers of 121 each= 847
One layer of 150

Total=2149

124. Proposed by ALOIS F. KOVARIK, Instructor in Mathematics and Science, Decorah Institute, Decorah, Iowa.

At what time between 5 and 6 o'clock is the minute hand midway between 12 and the hour hand? When is the hour hand midway between 4 and the minute hand?

I. Solution by M. A. GRUBER, A. M., War Department, Washington, D. C.

Take a and $a+1$ as the hours between which the conditions are to happen.

Let x=the distance, after a o'clock, the minute hand must move.

Let $\frac{1}{12}x$=the distance the hour hand moves.

(1). The first question of the problem involves two positions.

(a). In the first position, we readily find $5a+\frac{1}{12}x=2x$.

$$\therefore x=\frac{60a}{23}.$$

(b). In the second position we find $5(12-a)-\frac{1}{12}x=2(60-x)$.

$$\therefore x=\frac{60(12+a)}{23}.$$

Now put $a=5$. Then, in the first position, $x=13\frac{1}{23}$; and the time is $13\frac{1}{23}$ minutes past 5 o'clock.

In the second position, $x=44\frac{8}{23}$; and the time is $44\frac{8}{23}$ minutes past 5 o'clock.

(2). In the second question of the problem, take $4=b$.

Then, in general terms, we find

$$\frac{\pm(x-5b)}{2}=\pm[5(a-b)+\tfrac{1}{12}x].$$

$\therefore x=6(2a-b)$.

Plus of the double sign is to be used for $b<a$, and *minus* for $b>a$.

Put $a=5$, and $b=4$.

Then $x=36$, and the time is 36 minutes past 5 o'clock.

II. Solution by **J. OWEN MAHONEY**, B. E., M. Sc., Professor of Mathematics, Central High School, Dallas, Tex.; **COOPER D. SCHMITT**, A. M., Professor of Mathematics, University of Tennessee, Knoxville, Tenn.; and **JENNIE B. BRIDENBAUGH**, Student, Nebraska State Normal School, Peru, Neb.

Let x=the number of minute spaces over which the minute hand passes in each case. Then, in the first case, it is easily seen that

$$x+\tfrac{11}{12}x=25,\text{ or } x=13\tfrac{1}{23}.$$

Hence, at $13\frac{1}{23}$ minutes past 5 o'clock the first condition is satisfied.

In the second case,

$$x-2(\tfrac{1}{12}x+5)=20,\text{ or } x=36.$$

Hence, at 36 minutes past 5 o'clock the second condition is satisfied.

III. Solution by **B. F. FINKEL**, A. M., M. Sc., Professor of Mathematics and Physics, Drury College, Springfield, Mo.; and **J. T. FAIRCHILD**, Principal, Crawfis College, Ohio.

A. 1. $\frac{2}{2}$=distance hour-hand moves past 5.

2. $\frac{24}{2}$=distance minute-hand moves in the same time.

3. $\frac{2}{2}+25$ minutes=distance from 12 to the hour-hand.

4. $\frac{1}{2}$ of $(\frac{2}{2}+25$ minutes$)=\frac{1}{2}+12\frac{1}{2}$ minutes=distance from 12 to the minute-hand, since it is to be half way between 12 and the hour-hand.

5. $\therefore \frac{24}{2}=\frac{1}{2}+12\frac{1}{2}$ minutes.

6. $\therefore \frac{23}{2}=12\frac{1}{2}$ minutes, and

7. $\frac{1}{2}=\frac{1}{23}$ of $12\frac{1}{2}$ minutes$=\frac{25}{46}$ minutes, and

8. $\frac{24}{2}=24$ times $\frac{25}{46}$ minutes$=13\frac{1}{23}$ minutes, the time past 5, when the minute-hand will be midway between 12 and the hour-hand.

B. 1. $\frac{2}{2}$=distance hour-hand moves past 5.

2. $\frac{2}{2}+5$ minutes=distance from 4 to hour-hand.

3. $\frac{4}{2}+10$ minutes=distance from 4 to minute hand, since hour-hand is half way between 4 and the minute-hand.

4. $\frac{4}{2}+30$ minutes=distance from 12 to minute hand.

5. $\therefore\ \frac{24}{2}=\frac{4}{2}+30$ minutes.

6. $\therefore\ \frac{20}{2}=30$ minutes.

7. $\frac{1}{2}=\frac{1}{20}$ of 30 minutes$=1\frac{1}{2}$ minutes.

8. $\frac{24}{2}=24$ times $1\frac{1}{2}$ minutes=36 minutes=time past 5.

IV. Solution by Hon. **JOSIAH H. DRUMMOND**, Portland, Me.; **ALOIS F. KOVARIK**, Instructor in Mathematics and Science, Decorah Institute, Decorah, Ia.; **W. MANZILLA**, Instructor in Mathematics, Langston University, Langston, Okla., and **JOHN M. COLAW**, A. M., Monterey, Va.

As the minute-hand travels over twelve minute-spaces while the hour-hand is going over one, the distance from XII to the hour-hand is $25+\frac{1}{12}$ of the distance the minute-hand travels; and one-half of this is $\frac{25}{2}+\frac{1}{24}$ of that distance.

Hence, $\frac{25}{2}$ is $\frac{23}{24}$ of that distance which is $13\frac{1}{23}$, and the time is $13\frac{1}{23}$ minutes past five.

Second. Of course at two o'clock the hour-hand is precisely half-way between IV and the minute-hand.

Again, while the minute-hand travels from XII to IV, the hour-hand goes over $\frac{20}{12}$ minute-spaces. Hence $\frac{20}{12}+\frac{1}{12}$ of the distance the minute-hand travels after it reaches IV=one-half of that distance.

Hence $\frac{20}{12}$ is $\frac{5}{12}$ of that distance which is four. And the time required is twenty-four minutes past four.

ALGEBRA.

99. Proposed by **CHARLES HALLETTE JUDSON**, Professor of Mathematics, Furman University, Greenville, S. C.

Seven persons met at a summer resort, and agreed to remain as many days as there are ways of sitting at a round table, so that no one shall sit twice between the same two companions. They remained fifteen days. It is required to show in what way they may have been seated.

I. Solution by **P. H. PHILBRICK**, C. E., Chief Engineer for Kansas City, Watkins & Gulf Railway Co., Lake Charles, La.

Each person has six companions; and the the number of ways of sitting are, therefore, equal to the number of ways of selecting two out of six or 6.5/1.2 =15 ways.

II. Solution by the **PROPOSER**.

I give below the seating of 6 persons 10 ways, and of 8 persons 21 ways, but I have failed to get a correct seating of 7.

n persons can be seated in $\dfrac{(n-1)(n-2)}{2}$ ways.